Managing Incidents on Urban Arterial Roadways

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Limiting the impact on traffic of nonrecurring events such as crashes, traffic stops, or disabled vehicles through effective incident management should be one objective for emergency response professionals. Moreover, such management is an integral part of Intelligent Transportation Systems planning. The Arterial Incident Management Study, sponsored by the Illinois Department of Transportation and conducted by Northwestern University, examined the impact and management of arterial street incidents to determine what steps could be taken to improve the handling of such events. Several approaches were used to accomplish this, including (*a*) analysis of incident data from police and fire agencies, (*b*) debriefings of responders about specific incidents, (*c*) observation and videotaping of incidents, and (*d*) an incident management simulation workshop involving police, fire, emergency medicine, tow operator, public works, insurance, and media professionals who have responsibilities for incident management. A series of incidents were simulated in a workshop and consensus was sought on specific and general management tactics. This paper describes study methods and summarizes the important issues and recommendations to improve incident management. Among the key needs identified are (*a*) response in a manner and with adequate resources to minimize the time an incident affects a scene, (*b*) rapid removal of vehicles and debris, (*c*) effective traffic control at and around the incident, (*d*) communication with motorists who may be affected by long-duration incidents, and (*e*) advanced, intra- and interagency planning for incident management. Recommended changes include education of drivers and professionals, legislation, communications, use of new technologies for communications and data collection, and advanced planning and coordination of on-site procedures, responsibilities, and priorities.

Limiting the effect on traffic of nonrecurring roadway events such as crashes, traffic enforcement, fires, or disabled vehicles should be an objective of emergency responders. Although the priorities of emergency response must focus on protection of life and property, failure to maintain safe and efficient traffic operations not only can increase the delay costs associated with incidents, but also can generate additional incidents, multiplying the individual and social costs of such events.

This paper summarizes the results of the Arterial Incident Management Study (AIMS) conducted for the Illinois Department of Transportation to determine the typical procedures used for incident management on urban arterials, define improved incident management strategies, and identify avenues for implementing such strategies. For the purposes of this study, roadway incidents were defined as any unexpected events that have the potential to restrict the flow of traffic along an arterial roadway, that are temporary and localized in nature, and for which some form of intervention usually is necessary to complete and restore traffic flow.

The outcome of proper management also plays a key role in operating the roadway in conjunction with Intelligent Transportation Systems (ITS). Efficient operation requires roadways that are free of interruption; interruptions that occur are minimized to maintain a maximum flow of traffic. Planning associated with incident management should be considered an important part of ITS planning.

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BACKGROUND

Much of the previous work on incident management had focused on limited access highways (*1*). As far back as the 1950s, the disruptive potential of incidents on such roadways was recognized and steps were taken to detect incidents and provide information to motorists. Enhanced technologies for incident detection on limited access highways have reduced response times and have brought opportunities for reducing the duration and intensity of impact on traffic.

Incident management on urban arterial roadways differs in several ways from that on an expressway. First, automated incident detection is more complex because the normal interruptions resulting from traffic signals mask the flow effects of incidents (*2*). On the other hand, detection and reporting of incidents often is facilitated by the close proximity of roadside observers and availability of telephones. In contrast to the expressway, the arterial offers more operational and network flexibility. In most settings, multiple alternative routes are available, allowing affected motorists to find paths that avoid incident-related delays. Responders also can access incident sites by multiple paths, which may reduce delays.

AIMS focused on a problem common to incident management in most roadway environments but particularly on arterial streets: protection and maintenance of traffic operations during incidents and rapid clearance of obstacles and visual distractions are not high priority objectives for emergency responders. In fact, most responders appear to be unconcerned about how their actions affect traffic, although in many cases their actions were observed to exacerbate congestion.

This premise was the basis for the study and was confirmed through a variety of field observations and discussions with emergency response professionals. That the problem may be worse on arterial streets than limited-access roadways may be because state patrols are often responsible for law enforcement on the limited-access roadways and their responsibility is focused on traffic operations, whereas local police have broader responsibilities. Fire fighters and paramedics rarely see traffic management as their concern.

CONTEXT AND APPROACH

This study was conducted in the Chicago metropolitan area, and data collection focused on seven suburbs in the northwest quadrant having a combined 1990 population of about 275,000. The suburbs

were Arlington Heights, Buffalo Grove, Elk Grove Village, Mount Prospect, Palatine, Prospect Heights, and Rolling Meadows. The distribution of incidents by type for a 28-day sample period from January 9 through February 5, 1995, was as follows: crashes, 35 percent; stops for traffic violations, 30 percent; disabled vehicles, 27 percent; and the remainder (e.g., signal malfunctions), 8 percent. The traffic stops represent only those for which voice communication existed, generally more serious offenses; action on a large percentage of traffic stops is performed computer to computer. The remaining 8 percent included fires, signal outages, railroad gate malfunctions, debris, and lane blockage such as that caused by a water main break.

The study was conducted in the following steps:

- Review of the literature.
- Collection and analysis of incident records from cooperating police departments in the study area.
- Field observation and videotaping of more than 20 incidents during trips with cooperating police departments, along with independent observations.
- Debriefings on specific incidents, in which personnel from police and fire agencies who responded to these incidents described, discussed, and evaluated events and procedures. These debriefings helped capture an understanding of incidents from those who managed them and derived incident management issues and recommendations from professional emergency responders.
- Eight hours of incident simulation using a panel of experts from various fields concerned with the management and aftermath of incidents. Participants included police, fire fighters, emergency medical technicians, dispatchers, a tow operator, insurance company representatives, traffic engineers, and a representative of the electronic media. These simulations were "board games" based on real incidents observed by the research team. Scale-model vehicles were used and participants worked as a group to decide on vehicle placements, response patterns, and actions.

MANAGING AN INCIDENT

Objectives

Whether an incident occurs along an urban arterial roadway or on an expressway, the objectives for managing either type should be to

- Protect life and property;
- Minimize capacity loss (flow disruption) duration, intensity, and geographic extent; and
- Gather required investigative information.

Incidents, especially those occurring during peak travel periods, create congestion, which brings associated costs of increased fuel consumption and pollution (*3*,*4*) and delay and attendant frustration (*5*). Also, as discovered in this research, incidents provide a significant opportunity for secondary crashes (*1*). Therefore, minimizing capacity loss should be assigned a high priority along with protecting life and property.

Figure 1 outlines the typical event structure of an incident, illustrating the usual phases and describing the elements that affect each phase, including outcome measures and processes. The response phase starts when the incident occurs and is completed when the situation is resolved, that is, when a crash and its aftermath are cleared from the roadway and traffic returns to normal.

The potential for disruption of traffic can be measured by time delays from the time the incident occurs until it is cleared. Delay is attributable partly to detection and reporting times, which in turn depend on the number, type, and effectiveness of detectors (including human observers), as well as communication channels. The speed and effectiveness of clearance activities may depend on the appropriateness of the resources dispatched: were the right equipment and personnel dispatched in a timely manner or were extraneous resources sent to further congest the scene and perhaps delay response to other incidents? These outcomes depend on the accuracy and veracity of those reporting the incident (i.e., police officers usually are a more valid source than the average citizen) and on the dispatch policies followed.

At the scene, two independent processes must be controlled and coordinated: management and amelioration of the incident itself, and control of the roadway system. Each of these is important and should be the responsibility of one or more professionals. Effective incident management requires communication between these two functions, which will advance through retrospective evaluation of the performance of these tasks and the evolution of procedures, policies, and working relationships among members of incident management teams.

Typical Arterial Incidents and Effects

Data from seven contiguous communities in the northwestern Cook County, Illinois, suburbs provided information about the extent and effect of incidents upon arterial roadways. For a 28-day period in January and early February 1995, a subset of data from 6:00 a.m. through 9:59 p.m. was chosen. The subset was selected because this period represented both the largest proportion of incidents and the time during which they would affect traffic most. As Table 1 illustrates, incidents were separated into five classes: crashes, disabled vehicles, traffic stops, fire, and other. Crashes are further divided into property damage only (PDO), injury, and other (generally hit and run, but also those for which the original data did not indicate the type of crash).

The mean and deviation in times derive from times recorded at the entry of the dispatch until the officer reported clear of the scene. Time could have elapsed before the telecommunicator received the call, although the assumption was that most requests for service were reported within 1 or 2 min of the incident's occurrence (*6*). Clearance times were adjusted if possible to reflect when the incident and service vehicles no longer were directly affecting travel on the roadway.

Crashes affected the roadway for an average of 57 min with a deviation of 35 min. Other incidents, such as crossing gate malfunction, affected the roadway the least amount of time, 22 min with a deviation of 16 min. The event that affected the roadway the longest was a traffic crash with injury, showing an average time of 71 min. Overall, an incident could be expected to affect the roadway approximately 38 min with 67 percent of the incidents lasting between 4 and 72 min.

During the peak travel hours, 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 7:00 p.m., traffic demand on most of the arterial roadways within the study area was at or above capacity. Even a small disturbance can generate significant delay. What is not readily available from the literature are data showing capacity when lanes are blocked. Therefore, estimating delay from the available incident data would be difficult. Some further study is being done under this project to attempt to measure capacity at incidents. Early results suggest that capacity on a four-lane roadway is reduced between 55 and 70 percent when one lane is blocked.

To illustrate how a minor incident can result in significant traffic delays, the following are several incidents observed during the study:

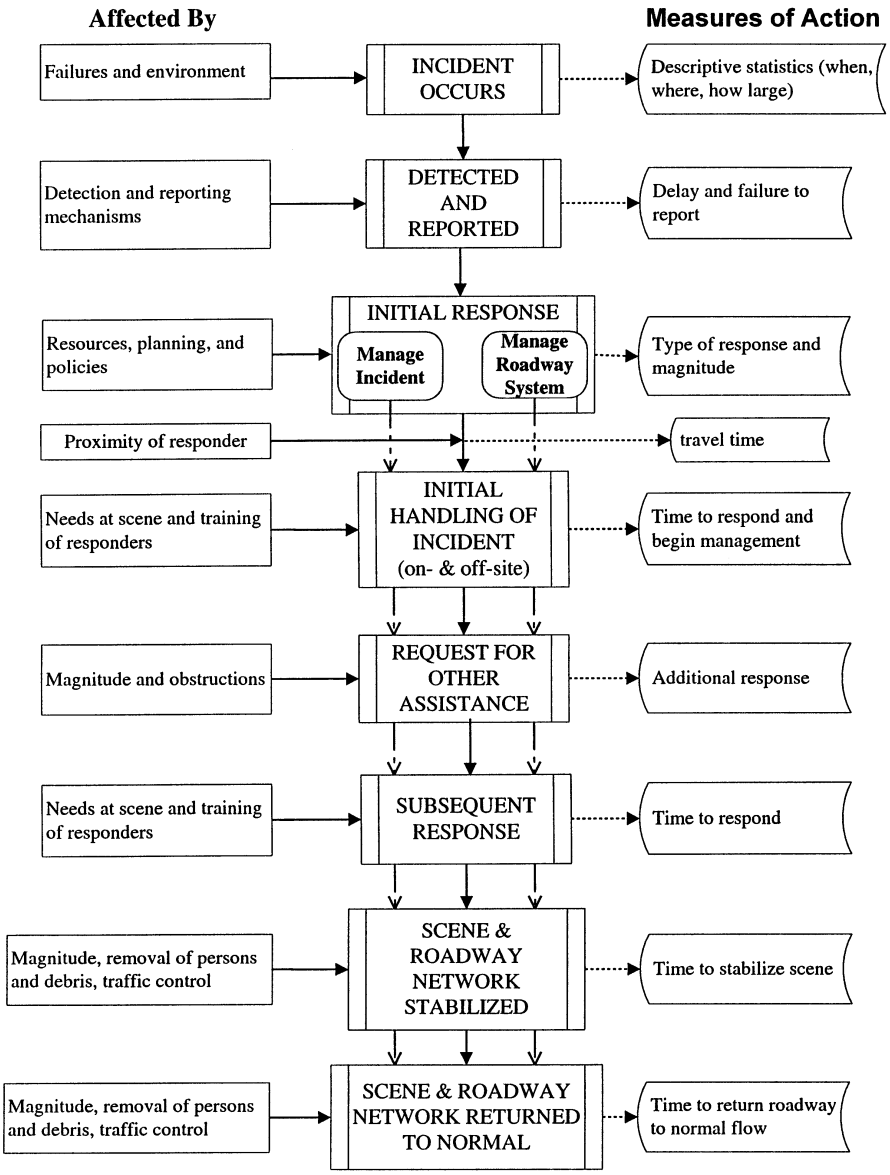

FIGURE 1 Phases of incident management.

• Two-car intersection crash. A two-car, noninjury crash at 4:00 p.m. in the intersection of two busy arterial roadways left one car blocking a southbound lane and a westbound lane. The tow service arrived 25 min later and drove the blocking vehicle off the roadway before towing it.

• Car fire on shoulder. A fire in a car parked along the shoulder of a six-lane divided roadway was being handled by the fire department. One fire truck blocked the outside lane and another blocked part of the middle lane to protect the fire truck in the outside lane. A driver moving around the fire truck stopped to look at the incident and was struck by a second vehicle. Both vehicles had to be towed and the driver of the first car was taken to the hospital. One direction of travel was closed for more than 60 min.

• Three-car crash. Drivers involved in a three-car, PDO crash along a very busy four-lane roadway waited at the spot of the crash for the police, who arrived 20 min later and blocked one lane of travel.

TABLE 1 Analysis of Incidents Occurring Along Arterial Roadways, January-February 1995

	Class of Incident								
Statistics	CRASH PDO	CRASH INJURY	CRASH OTHER	ALL CRASHES	DISABLED VEHICLE	TRAFFIC STOP	FIRE	OTHER	ALL INCIDENTS
Frequency	465	112	23	600	429	339	37	92	1497
Time in minutes									
Mean	54.5	71.4	47.7	57.4	25.3	24.6	31.9	21.7	38.0
s.d.	32.8	40.0	30.7	34.8	30.0	21.8	40.4	16.0	34.1

All vehicles later were driven from the scene. On arrival, a police officer took the crash information without moving the vehicles. At one point traffic was backed up more than 3 km.

KEY ISSUES IN INCIDENT MANAGEMENT

Field observations, published literature, incident debriefings, and experience of the research team identified the following issues and problems:

- Responders' lack of concern for and knowledge of traffic impact, resulting in failure to manage traffic;
- Limited initial information about an incident to support dispatching response;
- Poor on-site coordination and failure to provide on-scene command by responding agencies;
- Too many responders at the scene;
- Excessive incident duration;
- Debris and vehicles left on the roadway too long;
- Failure to secure timely and appropriate tow services;
- Failure to involve appropriate agencies with needed expertise or authority, such as public works, for long-duration traffic control;
- Poor or no communication with motorists approaching the scene; and
- Poor evaluation and intra- and interagency planning.

These outcomes lead to increased risk for involved motorists as well as for emergency responders. They increase delays and the probability of secondary collisions. [Using simple time and distance propinquity criteria, data from approximately 1,700 incidents in seven communities in northern Cook County, Illinois, suggest that as many as 15 percent of all crashes may be related to prior incidents (*7*)]. Recommendations in this paper address the issues listed and are presented in four general categories: Notification and Response, Scene Management, Communication with Motorists, and Planning and Evaluation. A common thread among these recommendations is communication—with the reporter of the incident, with responders, among personnel at the scene, and with motorists affected by the event. Effective and timely communication should reduce the time responders must be on-scene and reduce motorist delay and associated costs.

RECOMMENDATIONS

Notification and Response

To provide a timely and appropriate emergency response to an incident, call-takers must obtain accurate information on the location, nature, and scale of an incident. Typically, public safety call-takers differentiate between information received from civilians and that coming from public safety officers. Commonly civilian reports are suspect, whereas reports from professionals are considered more reliable. In some cases there is a delay in dispatching a full response until a safety professional, usually a police officer, arrives at the scene to provide a better report. If better initial reports can be extracted from lay observers, some of this delay can be eliminated.

Responsibility to assess the need for the best initial response lies with the call-taker, who generally is the public safety telecommunicator. Also receiving calls are tow services and motor clubs. It is increasingly common for communities to have no-fee cellular emergency numbers operated by contractors who relay requests for response, generally without follow-up responsibility or capability (many communities are moving to cellular 911 numbers answered by public agencies).

To improve this aspect of incident management, the public can be trained to report incidents. Their reports should include location, event type, and intensity (e.g., extent and number of injuries, fires, number of vehicles, types of vehicles, road blockages, spills, rollovers). The public can be educated through brochures distributed by motor clubs and those sent with vehicle registration and driver license renewal mailings or with vehicle insurance premium notices, through formal instruction for students in driver education courses, and through training material provided to those frequently on the road, such as tow operators, bus drivers, utility personnel, and taxi drivers.

Public safety personnel and other call-takers can be trained to gather, assimilate, and summarize information received from the public. Often, institutions such as the Northwestern University Traffic Institute conduct specialized training for telecommunicators; training for roadway incident management could be incorporated in these courses. Call-takers and telecommunicators need the knowledge and authority to select the level of response required and to decide which agencies to notify. Furthermore, it may be appropriate for telecommunicators to play a continuing role in the management of ongoing traffic incidents because they may be able to see the bigger picture. For example,

- The call taker should instruct motorists to move their (drivable) vehicles off the roadway before the police arrive (*8*).
- Public safety telecommunicators need a menu of response options dependent on the call; this process might be supported by a knowledge-based expert system. Field experience with relaxed dispatching rules should provide a basis for an enhanced response plan that would balance too much response against quick response when needed.
- In the case of larger, long-duration incidents, telecommunicators need the authority and ability to alert motorists and provide information on alternate routes.

Finally, educational material can be provided to other call-takers (tow services, utility operators, public works agencies) to inform them how to collect information that will be of value to public safety responders.

Scene Management

Management of the scene starts when the first responder arrives and ends when traffic flow returns to normal. The interactions among incident responders are depicted in Figure 2. Police, fire, and tow services typically work somewhat independently of the others. Public works departments rarely are involved except when the incident is their direct responsibility, such as road damage, or when a long-term detour may be required. Most important, traffic flow and communication with motorists largely are ignored in the current model.

Most frequently a police officer is the first responder, because either he or she witnessed a driver or motor vehicle violation or there has been a crash. In fact, the police officer handles most incidents alone because traffic stops and property damage accidents represent at least two-thirds of all roadway incidents. The effectiveness of on-scene management at these incidents depends on the experience and training of those officers. What is not done effectively by police is coordination when more than one officer or agency is involved with the incident.

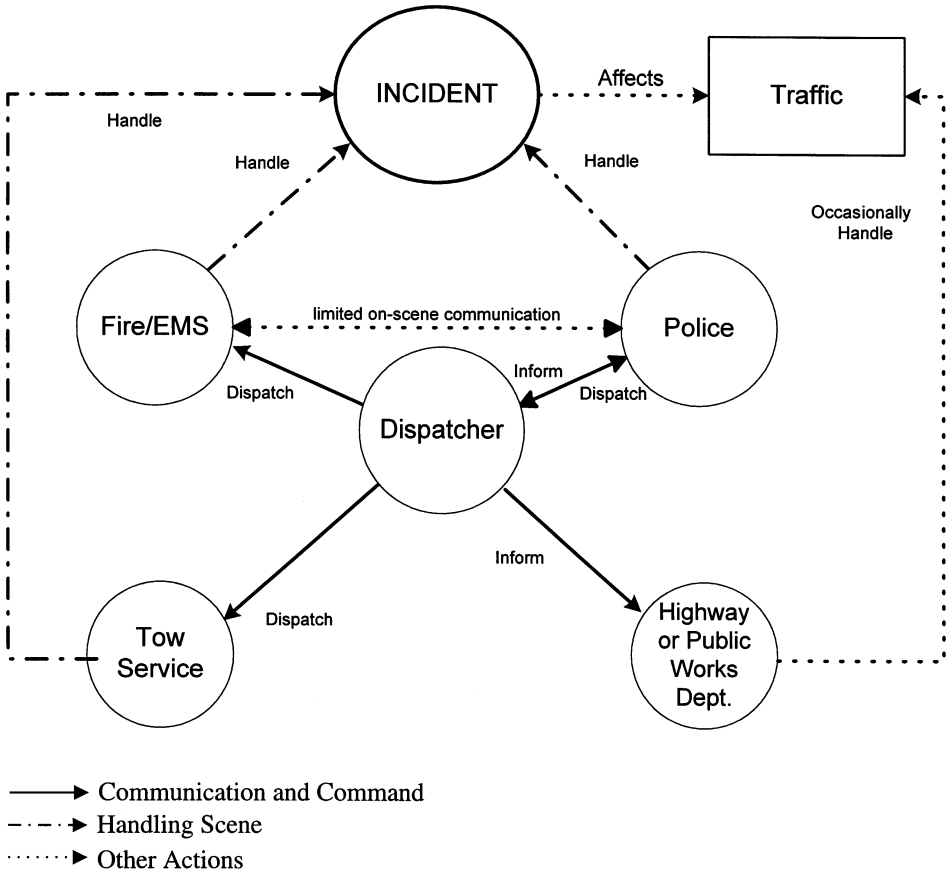

FIGURE 2 Traditional model of incident management.

Fire personnel, who respond to vehicle fires, most hazardous materials spills, and injury accidents, normally work as a team with the ranking fire official in charge of the scene. This management structure usually supersedes management by police or other agencies; other responders remain secondary players, often with little or no direction or communication from fire officials.

A revised model for handling incidents is shown in Figure 3. This model evolved from the observation of an absence of procedures for assigning and assuming command at the scene, command that includes responsibility for traffic operations. The two most important contributions of this revised model are that the police assume a command and coordination role and that other responders, such as tow services, public works agencies, and the motorists, are an integral aspect of scene management.

First responders, whether police, fire, or tow operators, often have substantial opportunity to make decisions that minimize the traffic effects. Therefore, several key recommendations are aimed at them:

- The responding vehicle should be parked to provide required protection of the scene, yet (if possible) to maintain traffic flow and provide space for vehicles of subsequent responders. If it is not possible to maintain traffic flow, immediate action (or request for assistance) should be directed at implementing a traffic diversion scheme.
- A triage of the scene should be performed to determine task priorities and needs for additional response. A checklist that provides guidance regarding use of resources, traffic management, and removal of obstacles can prove valuable.
- Correct tow services should be requested as soon as the need is recognized to minimize delay in removal of disabled vehicles.

The first responding police officer by default must become the scene commander until relieved or until the nature of the incident shifts so that some other agency, such as the fire department, becomes responsible. On-scene command responsibilities must balance the objectives listed earlier and must include safe and efficient traffic management. All potential scene commanders, which in some jurisdictions may mean all police and fire officers, should know and understand a policy and procedures framework on which to base their minute-to-minute decisions.

Telecommunicators (dispatchers) often play ongoing roles in larger and longer-duration incidents. For example, they may receive and respond to requests for additional assistance at the scene and often provide communications relay services for responders communicating on different radio frequencies. In many cases telecommunicators are in an excellent position to provide more advanced scene coordination, even though they are blind to the scene itself.

Telecommunicators should be trained to function more actively as off-scene coordinators. That training should include role-playing and ride-along experiences with responders. More use of off-scene coordinators can be a way of sharing scarce skilled and experienced incident management personnel, especially across several near-simultaneous events. The effectiveness of off-scene coordinators may be increased by providing them with additional, real-time information about conditions and events at the scene. Real-time video images may be transmitted to the telecommunications center, and

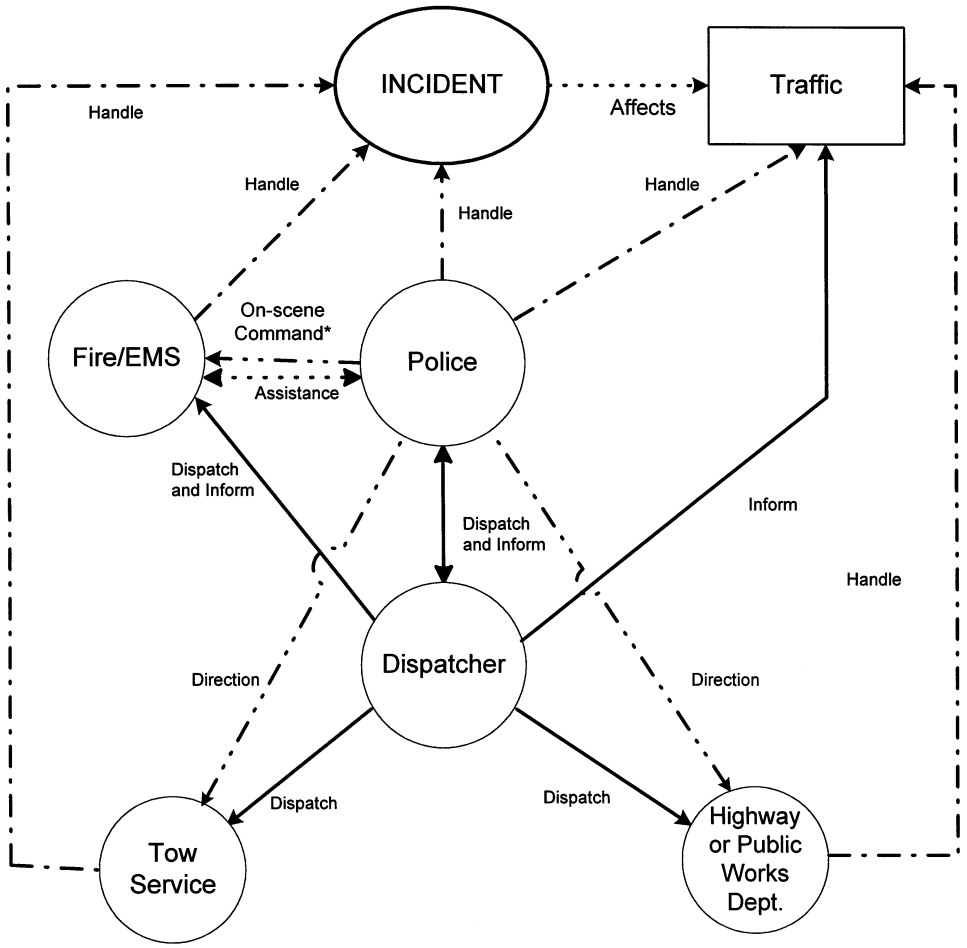

FIGURE 3 Revised model of incident management.

larger jurisdictions may find this a way to amplify the capability of off-scene coordinators. Communication with the broadcast media should be maintained.

Because traffic management often is not considered, incidents frequently produce unnecessary delay and the associated costs of increased fuel usage, pollution, and lost time. Where necessary, on-scene personnel should provide traffic direction and, in the case of major roadway blockages (more than 30 min) or capacity reductions, provide adequate traffic rerouting. Traffic direction can include changing signals to an all-red flashing phase so that personnel can control traffic, and providing mobile arrow boards or directional signs to direct motorists around obstacles or into new traffic patterns; emergency response vehicles should carry or have rapid access to such signs and cones.

A detour should be considered when an entire roadway must be closed for more than 30 min or when use of opposing traffic lanes is not feasible because of median barriers or heavy traffic use. Detours can be implemented in two stages. A simple detour using portable barricades with directional arrows, or even cones, can be installed quickly. When the delay is expected to last for several hours, a more comprehensive plan can be put in place.

Generalized plans for detour routes should be planned in advance and implemented with assistance from public works department personnel. Off-scene coordinators (telecommunicators) or public works representatives can provide the "big picture"—larger-scale network effects, feasibility of maneuvers, and ways to guide diverted motorists.

The training of both fire and police personnel should reinforce the need to, and ways to, minimize lane blockage at an incident. An important method is to develop simulations or board games that public safety personnel can use to understand how traffic control affects both the handling of the incident and the traffic within the network affected by the incident.

Public works departments should be part of scene management resources, their specialized services to be available to support rerouting and traffic management when needed. Where incidents

have widespread effects across a network, consideration should be given to assigning auxiliary (police) personnel, community services officers, or supervisors to traffic control and parking enforcement.

Impact of the emergency response activity itself should be minimized. Excess personnel, equipment, and lights can distract the attention of passersby, create delay-causing gaper blocks, and cause other crashes. Police, fire, and other responders not needed at the scene should be reassigned or at least relocated off the roadway. This should be the responsibility of the on-scene commander. When responders finish their specific tasks, they should remove or relocate their vehicles out of view to reduce distractions to motorists. Once vehicles are in place, unnecessary emergency lighting (i.e., that which faces traffic in opposite lanes) should be turned off. This includes wig-wag headlights. To prevent unnecessary locking of traffic signals near the incident scene, vehicles should be altered so that traffic signal prioritization methods such as Opticon are disengaged if the transmission of the vehicle is placed in park. Also, older Opticon units should be upgraded so that they are not triggered by strobe emergency lights.

Larger incidents and those requiring responses from several agencies create the need for communication across agencies. The ability of responders to share a common radio frequency is highly desirable. This requires both Federal Communications Commission channel assignment and the availability of multichannel radios to field personnel. Portable cellular telephones offer an inexpensive and quickly implemented way for police, fire, tow, and public works personnel to communicate at and near the incident scene. Electronic bridges should be available in dispatch centers to allow telecommunicators to patch different communication channels together for interagency communication.

Vehicle and debris removal must be performed as soon as possible after any injured persons have been removed and hazardous materials have been secured. Unless a stop for traffic enforcement is made on the basis of a felony warrant for some dangerous action that cannot be allowed to continue, such as driving under the influence, police should direct violators to stop at locations off major roadways.

Any vehicle that can be driven or pushed from the roadway should be moved as quickly as possible. Legislation should be introduced requiring that vehicles involved in minor collisions and drivable be removed from the roadway before police are contacted. This legislative change (already implemented in several states) needs support from police and insurance firms to reassure motorists that they do not jeopardize either their responsibilities or their rights by moving their vehicles out of the traffic stream before emergency responders arrive.

During peak hours, motorists should not have a right of tow refusal. If the caller indicates that the vehicle cannot be driven or pushed, then a tow service must be dispatched as soon as possible. Laws limiting liability to police, fire, and other responders should be enacted to minimize the likelihood that a tort action will arise if responders remove vehicles and debris expeditiously.

Spills from vehicles, whether the result of a crash or another problem, should be promptly removed (hazardous materials are the exception). Police vehicles should carry brooms to sweep away sharp debris such as glass.

Municipalities should write contracts for tow services to ensure that required services will be available. Tow lists should include contractors offering the specialized equipment likely to be needed, such as flatbed trucks to handle two vehicles per tow, heavy-lift trucks, and so forth. Municipalities should require periodic verification that tow contractors have the equipment and skills to remove vehicles and debris safely and efficiently. Police and telecommunicators must know when heavy-duty tow services or recovery is needed and whom to call.

To reduce further traffic impediments at the scenes of crashes, a variety of tactics can be used to make the investigation phase more efficient. Police should maintain diagrams of intersections most likely to experience collisions. These can be used to speed sketching of the scene and may preclude the need for some measurement. Such diagrams may already be on file with the public works department.

Electronic total stations can be used for at-scene measurement (*9*,*10*). With this technology, crash investigators trained in computer-aided surveying methodology can measure the scene rapidly and locate various relevant marks of the crash, reducing or eliminating the need for personnel to move across the roadway, interrupting traffic flow and putting themselves at risk. The resulting data can be transferred to a computer-aided drafting program and sketches of the scene done by computer.

Many agencies nationwide use trained civilian traffic crash investigators to handle all investigations, leaving official personnel to manage the scene.

In a growing practice, police require motorists involved in minor property damage crashes to file a report at the police station. This clears the scene quickly and saves trained personnel for more important duties.

Communication with Motorists

Motorists frequently are unaware of an incident until they are caught in the resulting congestion, which leads to further delays and makes scene clearance more difficult. Policies and criteria should be established to guide telecommunicators and off-scene managers in disseminating information about large-scale, long-duration incidents.

Criteria for information dissemination should be based on the scale and scope of incidents (e.g., road closures or multiple-lane blockage of more than 30 min during peak travel). Prearranged media distribution channels should be established through agreements with broadcast stations and news bureaus. Written communications using e-mail, broadcast facsimile, or news service teletypes are most desirable to ensure clear and explicit messages. With computer-aided dispatch (CAD) systems, such messages can be formulated automatically and sent with a single command, eliminating manual formatting and entry. Broadcast information for motorists should include specific guidance for revised routes. Rerouting should be designed to minimize adverse impact on the streets used.

Estimating incident duration is highly desirable to provide the most useful guidance to motorists (*11*). CAD systems usually store enough historic data so that duration can be calculated and changed as needed.

Planning and Evaluation

Planning is preparing for the future. For incident management, planning can provide responders with methods and tools for managing the scene and reducing the effect of an incident on traffic. Although handling a specific incident cannot be planned in detail, classes of incidents can be identified.

By careful review of incident history, police managers come to know locations, times, and classes of incidents likely to occur. Procedures should be in place that define for call-takers, public safety telecommunicators, responding officers, supervisors, and management what steps each should take to reduce the effects of the

incident. General and specific plans for detouring and rerouting traffic can be prepared by knowledgeable personnel in advance of major incidents.

Planning and coordination are needed across agencies within a jurisdiction to promote cooperation and efficiency among police, fire, tow service, and other involved entities. Joint planning should emphasize developing shared objectives, priorities, and agreement on responsibilities. For example, the Illinois Department of Transportation and the Illinois State Police have written agreements covering Interstate highways.

Planning also is required across jurisdictions to establish agreements defining the authority of one agency to handle incidents within the jurisdiction of another, based on availability of resources. An important step can be the delineation of boundaries of coverage so that one agency has responsibility for an entire segment or intersection when the segment or intersection lies within multiple jurisdictions.

An important foundation for planning is evaluation of existing policies, procedures, and their outcomes. This study found that debriefings among responders to specific incidents can provide a good basis for evaluation, problem solving, and cooperative relationships. Such debriefings should be regular activities of incident responders, allowing participants to review their own actions, those of others, and the overall management of the incident. In another mode of evaluation, police and fire supervisors should observe and evaluate the response to some minimum number of events each year to assess performance of their personnel in managing incident scenes.

CONCLUSION

This study found that a broad and integrated response to incidents that focuses on the victims, vehicles, material and personal hazards, and traffic operations is important to successful incident management. The job of handling an incident is not a series of disjointed tasks but a coordinated effort designed to expedite clearing the scene, protecting those involved, and reducing the effect on traffic.

Emergency responders are highly motivated and trained people who perform their specific tasks well. They are interested in completing their work promptly and returning to other duties. The study has attempted to define objectives and roles for each of the actors engaged in incident management and to suggest mechanisms through which they can learn to perform some of these roles more effectively. To meet these objectives requires a multifaceted approach including

- Education to inform and training to teach these roles;
- Policies and procedures that minimize the effect of incidents;
- Intra- and interagency planning, including joint working agreements;
- Communications channels and protocols to ensure efficiency of joint operations;
- On-scene command and off-scene coordination to ensure the successful performance of tasks and coordinated efforts; and
- Appropriate and timely communication with motorists.

Achieving these objectives will contribute to improving incident management. It will allow those immediately responsible for incident management to reduce time spent at the scene and exposure to injury. More important, it will help reduce the significant costs to motorists affected by the incident, both the direct costs of fuel usage and increased property and personal losses resulting from increased crashes and the indirect costs of delay, frustration, and increased pollution.

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